OPERATION/SERVICE MANUAL

HEATH ZENITH

HEATH ZENITH

Model WH8-16
16K STATIC MEMORY

595-2082-04

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INTRODUCTION

The WH8-16 16K Static Memory circuit board uses the latest in static memories. These memories require a minimum amount of power while providing fast response. An on-board switch allows you to locate the memory board throughout the available memory area. Plug-in capability combined with low density makes this circuit board easy to use. Your H8 Digital Computer provides for the addition of memory.

SPECIFICATIONS

Organization	16384 × 8.
Access Time	450 nsec maximum.
Interface	Compatible with H8 bus. All inputs are 1 TTL load or less. Data out buffer: 74LS240.
Address	Programmable in 4K boundaries.
Power Requirements	7 - 12 volts DC at 1.25 amperes.

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features previously sold.

NOTE: If the shipping carton shows evidence of rough handling, inspect the circuit board carefully for damage. Report any damage immediately to the carrier.

Your 16K Static Memory circuit board was carefully assembled and checked at the factory prior to shipment. You will, however, have to address this circuit board at the proper place in your Computer's available memory area.

MEMORY ASSIGNMENT

The H8 system requires the memory to start at 8K (refer to "System Considerations" in your H8 Operation Manual and the table in the "Circuit Description" in this Manual). This memory is normally located in one continuous block.

The first memory block must always start at 8K (040). Additional memory, up to 64K, must start where the previous memory block ends. The table below shows the relationship between the memory size and the starting addresses.

Abbreviated Memory Size (Decimal)	Actual Memory Size (Decimal)	Starting Address (high byte — octal)
8K	8,192	040
12K	12,288	060
16K	16,384	100
20K	20,480	120
24K	24,576	140
28K	28,672	160
32K	32,768	200
36K	36,864	220
40K	40,960	240
44K	45,056	260
48K	49,152	300

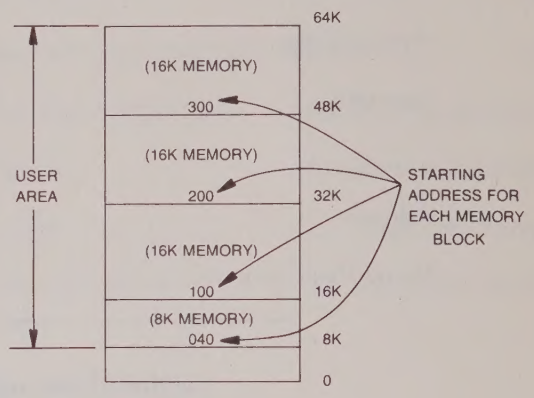
Since the H8 Computer can accommodate only a 64K memory, you can use one 8K and three 16K memory circuit boards:

1 — 8K Static Memory Circuit Board

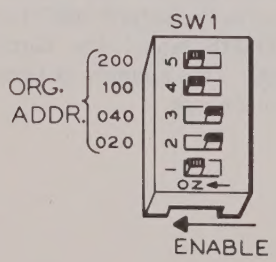
3 — 16K Static Memory Circuit Board

Do not program the starting address of the 16K Static Memory circuit board to start higher than 48K or you will cause memory to wrap around into the ROM area reserved for the H8 front panel monitor.

Install and address them as shown in the following example memory map.



The programming switch assembly (SW1) lets you quickly and easily select the starting address. The lower switch (1) is normally pushed to the left (enabled), to enable the circuit board. Push it to the right if you want to disable the entire circuit board without losing the data stored in memory. The other four switches (020, 040, 100, and 200) select the starting address. The numbers to the left of these switches (020, 040, etc.) are added together to obtain the desired address. For example, if you want the memory to start at the 48K address (300 octal), push the 100 and 200 switches to the left (enable). See Pictorial 1. Leave the 020 and 040 switches to the right (disabled).



PICTORIAL 1

INSTALLATION

Refer to Pictorial 2 for the following steps.

1. Be sure your Computer is turned off.

2. Remove the two rear panel screws holding the top cover and set the top cover aside.

3. Remove rear panel screw FD. Then loosen the other screws in the tie bracket, remove the bracket, and set it aside.

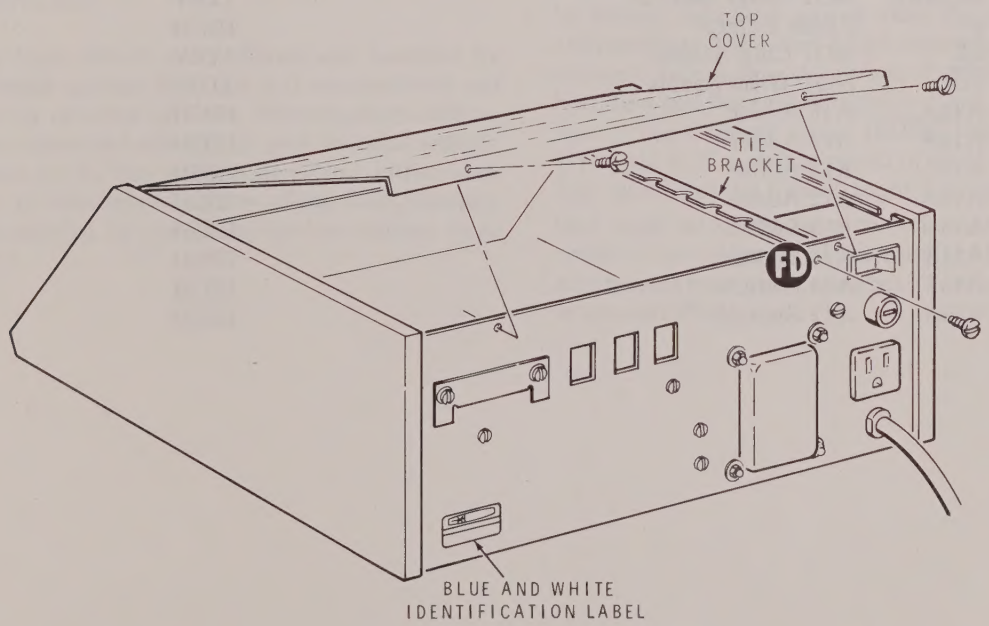
Refer to Pictorial 3 for the following steps.

NOTE: When you perform the next step, you will be directed to plug the memory circuit board onto a plug on the mother circuit board. Plug this circuit board behind the CPU circuit board or any previously installed memory circuit boards. If possible, leave a space between this circuit board and the other circuit boards.

4. Position the memory circuit board inside the chassis assembly as shown. Then carefully push the two connectors at S101 on the circuit board onto the selected plugs on the mother circuit board.

5. Secure the circuit board to the bottom of the chassis with a 6-32 × 1/4" screw.

6. Reinstall the tie bracket and top cover on the Computer. Be sure to secure the memory circuit board to the tie bracket with a 6-32 × 1/4" screw.



PICTORIAL 2

GLOSSARY OF TERMS

TERM	DEFINITION	SIGNAL TRUE CONDITION OCCURS WHEN LINE IS:
MEMR	Memory Read	HIGH
$\overline{\text{MEMR}}$	NOT Memory Read	LOW
$\overline{\text{SELMR}}$	NOT Select Memory	LOW
MEMW	Memory Write	HIGH
$\overline{\text{MEMW}}$	NOT Memory Write	LOW
$\overline{\text{SELMW}}$	NOT Select Memory Write	LOW
$\overline{\text{SELMWF}}$	NOT Select Memory Write Latched	LOW
$\overline{\text{BDSEL}}$	NOT Board Select	LOW
$\overline{\text{MEMSEL}}$	NOT Memory Select	LOW
RESET	Reset	HIGH
$\overline{\text{RESET}}$	NOT Reset	LOW
$\overline{\text{SELBK3}}$	NOT Select Bank 3	LOW
$\overline{\text{SELBK2}}$	NOT Select Bank 2	LOW
$\overline{\text{SELBK1}}$	NOT Select Bank 1	LOW
$\overline{\text{SELBK0}}$	NOT Select Bank 0	LOW
ø2	Phase 2 clock	HIGH
$\overline{\text{CE}}$	NOT Chip Enable	LOW
$\overline{\text{WE}}$	NOT Write Enable	LOW
A15A	A15 Adder	HIGH
A14A	A14 Adder	HIGH
A13A	A13 Adder	HIGH
A12A	A12 Adder	HIGH
A15S	A15 Switch	HIGH
A14S	A14 Switch	HIGH
A13S	A13 Switch	HIGH
A12S	A12 Switch	HIGH

CIRCUIT DESCRIPTION

Refer to the Schematic (Illustration Booklet), and the "Glossary of Terms," while you read this "Circuit Description." The following paragraphs are broken down into two groups called "Address Decoding" and "Read and Write Control."

The WH8-16 Static Memory circuit board is a 16,384 × 8 static memory. This is accomplished with four groups (bank 0, 1, 2, and 3) of 8-bit (bit 0 thru 7) memory IC's. Each IC provides a storage capacity of 4096 × 1 bits.

Data going into the memory array from the bus is buffered and inverted by the "from bus" buffers, one-half of U147 (D0 - D3) and one-half of U148 (D4 - D7). These buffers are enabled when pin 19 ($\overline{\text{SELMW}}$) is low.

Data from the memory to the bus is buffered and inverted by the "to bus" buffers, the other halves of U147 and U148. These buffers are enabled when pin 1 ($\overline{\text{SELMR}}$) is low.

Address lines A0-A7 are buffered and inverted by U146, while address lines A8-A11 are buffered and inverted by one-half of U145. These twelve address lines are connected directly to, and decoded within, each memory IC. The address decoding within each memory IC determines which of the 4096 memory cells is selected by the lower twelve address lines (A0-A11).

Address lines A12-A15 are buffered and inverted by the other half of U145. These four lines are inputs to the address decoder, U140. Address lines A12A and A13A determine which memory bank (0, 1, 2, or 3) is enabled. This is done in U141B, a 2-line adder.

A12A	A13A	BANK
0	0	0
1	0	1
0	1	2
1	1	3

Each of the four bank select signals (0, 1, 2, and 3) is connected to enable pins ($\overline{\text{CE}}$, pin 10) of its group of eight memories. This selection will occur only when the enable signal ($\overline{\text{EN}}$, pin 15) of U141 is low.

Since the entire 64K address field of the computer can be broken into four sets of 16K, the four states of address lines A14A and A15A determine which 16K memory field is selected. When A14A and A15A are both low and the enable input to U141 ($\overline{\text{EN}}$, pin 1) is low, a board select signal ($\overline{\text{BDSEL}}$) is generated at U141 pin 4. The enable signal to U141 ($\overline{\text{EN}}$, pin 1) is low whenever the RESET input (bus pin 29) is high (not reset) and SW1 (section 5) is closed. This also protects the contents of memory during power-up and system reset when the status of other bus signals is uncontrolled.

When the CPU wants data from memory, it sends a memory read signal (MEMR) out on the bus. This signal is buffered and inverted by U144F and gated through U143C by the board select signal ($\overline{\text{BDSEL}}$). When SELMR goes high, the output of U143D goes low, enabling the memory bank selector, U141B. SELMR going high also removes the reset from latch U143A and holds the 'D' input high. At the next phase 2 positive transition, the $\overline{Q}$ output will be set low, turning on the read buffers, U147 and U148. When the MEMR signal returns low at the end of the memory read cycle, the 4K memory bank will be deselected and U142A will be reset, turning off the bus buffers.

A MEMW signal is sent out on the bus whenever the CPU wants to write data into the memory. If the address on the bus has selected this memory circuit board, the inverted MEMW ($\overline{\text{MWR}}$) and the $\overline{\text{BDSEL}}$ cause the SELMW signal to go high. This is inverted by U143A and places a logic low at the write enable ($\overline{\text{WE}}$) input of all the memory IC's. The SELMW is also inverted by U144C to turn on the memory write buffers, U147 and U148. The clock signal $\phi 2$ is low when the SELMW occurs.

When the clock makes its next negative transition (having first gone positive) SELMW will set the Q output of U142B high, causing $\overline{\text{MEMSELR}}$ to go low. This selects one of the 4K memory banks by enabling selector U141B. At the end of the write cycle, SELMW returns low, resetting latch U142B.

Address decoder U141 decodes only addresses for the lowest 16K group (starting at 000 octal). The table below shows how the 16K static memory circuit board can be programmed to start at any 4K (020, 040, 060, 100, etc.) address.

ABBREVIATION	DECIMAL	OCTAL (HIGH BYTE)
0K	0	000
4K	4,096	020
8K	8,192	040
12K	12,288	060
16K	16,384	100
20K	20,480	120
24K	24,576	140
28K	28,672	160
32K	32,768	200
36K	36,864	220
40K	40,960	240
44K	45,056	260
48K	49,152	300
52K	53,248	320
56K	57,344	340
60K	61,440	360

Integrated circuit U140, a 4-bit adder, has two sets of four inputs and one set of four outputs. The outputs go to the inputs of U141 as explained previously. One set of four inputs (A12 - A15) comes from the address bus. The second set of four inputs comes from switch SW1. The four "ORG. ADDR." (origin address) switches of SW1 set the memory starting address of the circuit board. They may be set to any of 16 combinations ($2^4 = 16$) to select any one of the sixteen 4K boundaries.

IN CASE OF DIFFICULTY

This section of the Manual will help you locate and correct any difficulties which may occur during the operation of this circuit board.

The following "Memory Test Routine" will help you determine whether or not there is a problem on this circuit board.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of this Manual. Your Warranty is located inside the front cover.

MEMORY TEST ROUTINE

You will compare the B register in the Computer with the memory while the HL registers hold the address that is being tested. To start the test, you will write 000 into all memory locations, set the B register to 000, and set HL to the starting address. The HL register then increments up to the ending address as it compares each location with the B register. The B register is then incremented to 001 and each memory location is then incremented and compared with the B register. This process continues until the B register reaches 377 and repeats the test.

If the content of the memory location (that corresponds to the address in the HL register) does not agree with the value in the B register, the test halts and the alarm "beeps." This returns control to the front panel so you can isolate the failure.

Refer to "Use of the Front Panel" in your H8 Operation Manual to enter the following routine. NOTE: A more complete listing of this routine is in your H8 Operation Manual.

To test the 16K Static Memory circuit board:

a. Set the "ORG. ADDR." switches to 040.

b. Remove or disable all other memory circuit boards.

c. Run the memory test, starting with step 1 below.

1. Press MEM and enter 040 100.

2.Press ALTER and enter the following bytes:

ADDRESS	DATA
040 100	041
040 101	160
040 102	040
040 103	021
040 104	260
040 105	137
040 106	066
040 107	000
040 110	315
040 111	147
040 112	040
040 113	043
040 114	302
040 115	106
050 116	040
040 117	006
040 120	000
040 121	052
040 122	101
040 123	040
040 124	004
040 125	064
040 126	176
040 127	270
040 130	312
040 131	135
040 132	040
040 133	166
040 134	000
040 135	315
040 136	147
040 137	040
040 140	043
040 141	302
040 142	125
040 143	040
040 144	303
040 145	121
040 146	040
040 147	172
040 150	254
040 151	300
040 152	173
040 153	255
040 154	311

3. Press MEM.
4. Enter 040 100.
5. Press the + key and verify that you have entered the routine correctly.
6. Press REG.
7. Press PC.
8. Press ALTER.
9. Enter 040 100.
10. Press REG.
11. Press BC.
12. Press GO.

If the test routine is executed without difficulty, the B register (left 3 digits in the display) will increment from 000 to 377. When the display reaches 377, the test is complete and may be halted (press RTM and Ø).

If the test routine fails, the speaker will sound and the B register will indicate the memory **content** at which the test failed. The HL registers (press REG and HL) will display the memory **address** at which the test failed.

Memory failures generally fall in two categories: address and data. In a data failure, a particular number (or group of numbers) between 000 and 377 can not be written and then recalled from the memory. This may be caused by faulty data buffers or defective cells in the memory IC's. Since there are thirty-two memory IC's, one for each bit of each byte, it is possible to write a combination of bytes at the address where the test failed and determine which IC is at fault.

Addressing faults are the most difficult to isolate. They are caused by failures in the memory IC's. Often, more than one address will access the same location. If you recall the way the memory test operates, you can see that a given location will be incremented too often and cause the test to fail. When the memory test halts, try to write the current number (in the B register) into that memory location. If you can write the number into the location, the fault is address related.

These faults are difficult to locate, but a pattern will be evident if you study all of the failed address locations. (When the Computer is displaying the HL register, press the GO button after each failure and the test will proceed to the next failure.)

Write down the contents of the memory location that caused the test to fail. Then convert this octal number to binary. The least significant bit is D0; the most significant bit is D7. Compare the binary number with the previous memory location and with the number in the next memory location. The previous location contains the number as it should be, while the next memory location contains the number as it was previously. Compare the binary bits that caused the problem and the address of the problem to the following table. It will help you isolate the problem to a particular integrated circuit. Obtain the address of a failure from the HL register. Then refer to the table below to determine which IC is at fault.

ADDRESS	BANK	BINARY BIT NUMBER							
		D0	D1	D2	D3	D4	D5	D6	D7
040 000 — 057 377	0	U100	U101	U102	U103	U104	U105	U106	U107
060 000 — 077 377	1	U110	U111	U112	U113	U114	U115	U116	U117
100 000 — 117 377	2	U120	U121	U122	U123	U124	U125	U126	U127
120 000 — 137 000	3	U130	U131	U132	U133	U134	U135	U136	U137

PARTS LIST

NOTE: The following circuit component numbers correspond to the numbers on the Schematic and X-Ray View (Illustration Booklet).

CAPACITORS

CIRCUIT Comp. No.	HEATH Part No.	DESCRIPTION
C100-C107	21-95	.1 μF ceramic
C108, C109	NOT USED	
C110-C117	21-95	.1 μF ceramic
C118, C119	NOT USED	
C120-C127	21-95	.1 μF ceramic
C128, C129	NOT USED	
C130-C137	21-95	.1 μF ceramic
C138, C139	NOT USED	
C140-C146	21-95	.1 μF ceramic
C147, C149	NOT USED	
C148	20-102	100 μF mica
C150-C153	25-221	2.2 μF tantalum

INTEGRATED CIRCUITS (IC's)

NOTE: You may have received 443-910, 443-831, or 443-832 IC's in your kit. These IC's can be interchanged. However, if you order replacements or any of these IC's, order 443-910.

U100-U107	443-831	40L44-45NL
	OR	OR
	443-910	4104
U108, U109	NOT USED	
U110-U117	443-831	40L44-45NL
	OR	OR
	443-910	4104
U118, U119	NOT USED	
U120-U127	443-831	40L44-45NL
	OR	OR
	443-910	4104
U128, U129	NOT USED	
U130-U137	443-831	40L44-45NL
	OR	OR
	443-910	4104

Integrated Circuits (Cont'd.)

CIRCUIT Comp. No.	HEATH Part No.	DESCRIPTION
U138, U139	NOT USED	
U140	443-855	74LS283
U141	443-822	74LS139
U142	443-730	7402
U143	443-46	74LS74
U144	443-858	7414
U145, U146, U147, U148	443-754	74LS240
U149	NOT USED	
U150, U151	442-54	7805

RESISTORS

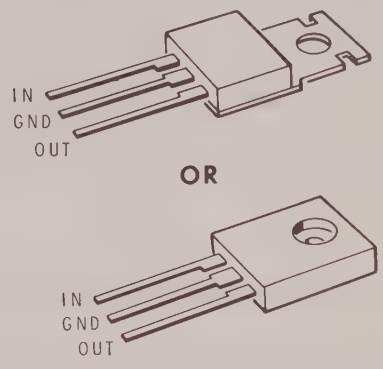
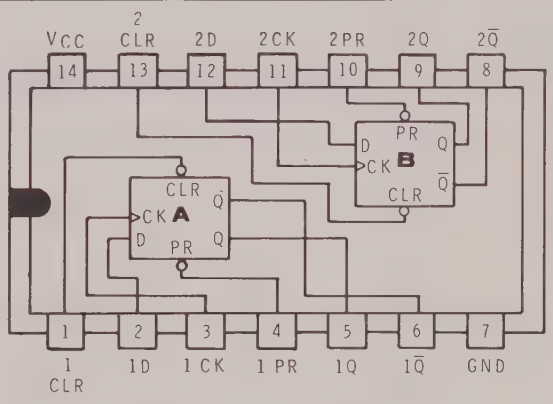
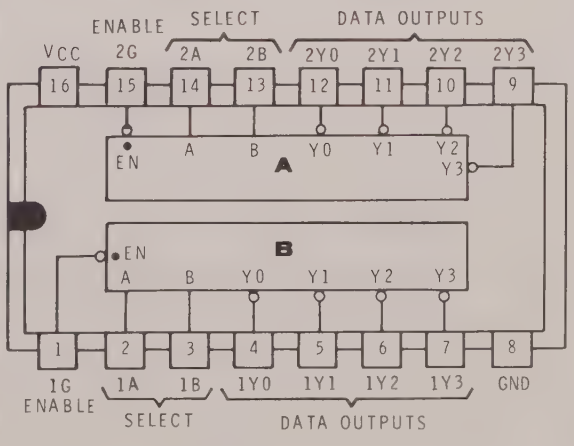
(All resistors are 1/4-watt, 1%)

R106-R109 R111-129 R131-R135	6-470-12	47 Ω
R143	6-271-12	270 Ω
R101-R105 R142	6-202-12	2000 Ω

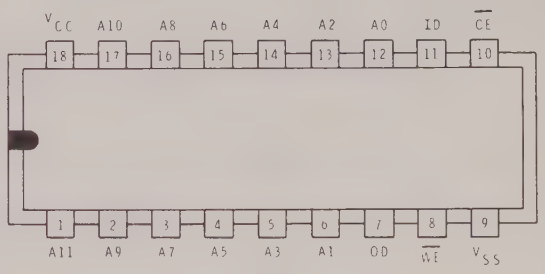
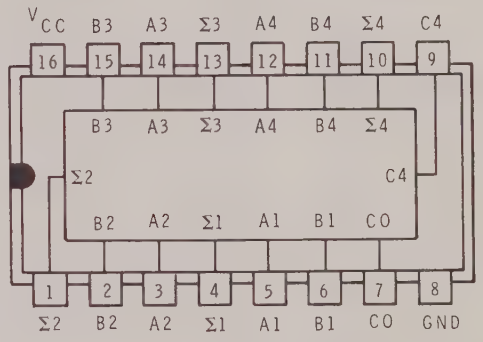
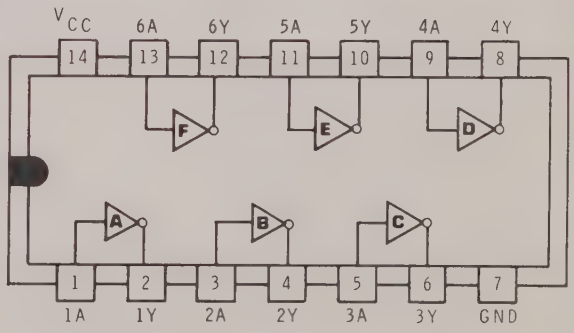
MISCELLANEOUS

SW1	60-626	5-section switch

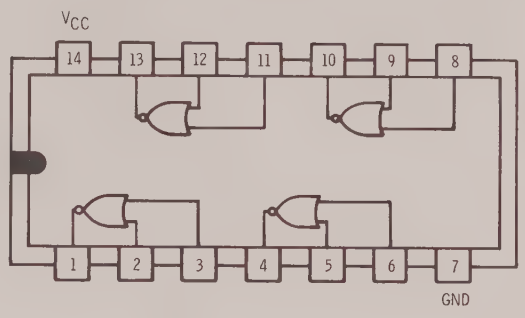
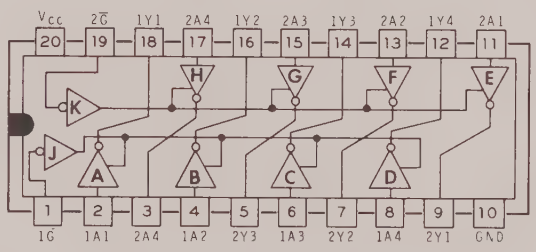
INTEGRATED CIRCUIT BASING DIAGRAMS
(Top view for all packages.)

HEATH PART NUMBER	MAY BE REPLACED WITH	DESCRIPTION	IDENTIFICATION
442-54	7805	5-VOLT REGULATOR	
443-730	74LS74	DUAL D-TYPE POSITIVE-EDGE-TRIGGERED FLIP-FLOPS	
443-822	74LS139	DUAL 2-TO-4 LINE DECODERS/MULTIPLEXERS	 ENABLE SELECT DATA OUTPUTS VCC 2G 2A 2B 2Y0 2Y1 2Y2 2Y3 16 15 14 13 12 11 10 9 EN A B Y0 Y1 Y2 Y3 A EN B A B Y0 Y1 Y2 Y3 1 2 3 4 5 6 7 8 1G ENABLE 1A 1B 1Y0 1Y1 1Y2 1Y3 GND SELECT DATA OUTPUTS

Integrated Circuits (cont'd.)

HEATH PART NUMBER	MAY BE REPLACED WITH	DESCRIPTION	IDENTIFICATION
443-831 OR 443-910	4104 OR 49L44-45NL	4096 WORD BY 1-BIT STATIC RANDOM-ACCESS MEMORY	
443-855	74LS283	4-BIT BINARY FULL ADDERS	
443-858	7414	HEX SCHMITT-TRIGGER INVERTERS	

Integrated Circuits (cont'd.)

HEATH PART NUMBER	MAY BE REPLACED WITH	DESCRIPTION	IDENTIFICATION
443-46	7402	QUAD 2-INPUT POSITIVE - NOR GATES	
443-754	74LS240	OCTAL BUFFERS/LINE DRIVERS/LINE RECEIVERS INVERTED 3-STATE OUTPUTS	

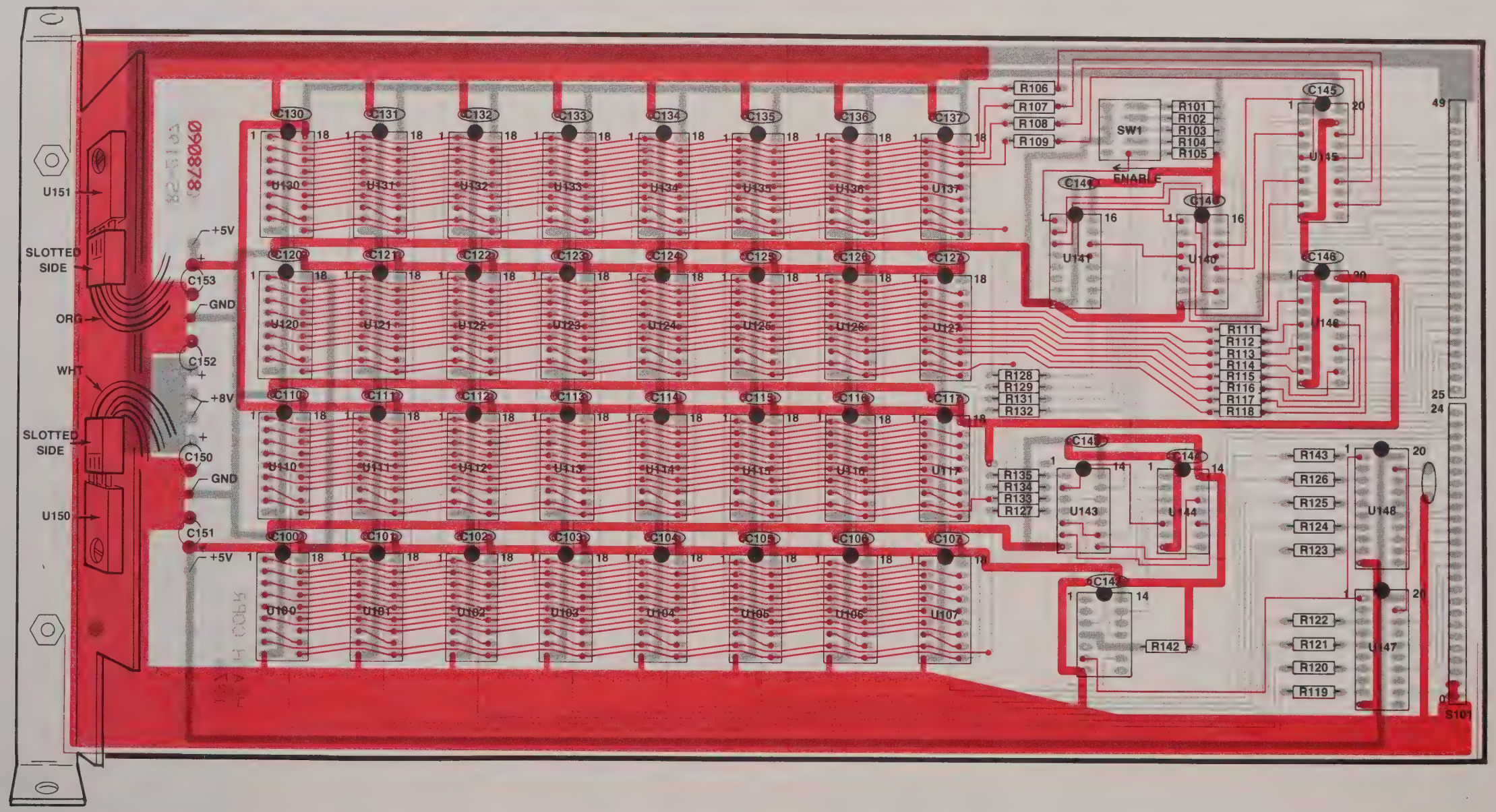
CIRCUIT BOARD X-RAY VIEW

NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

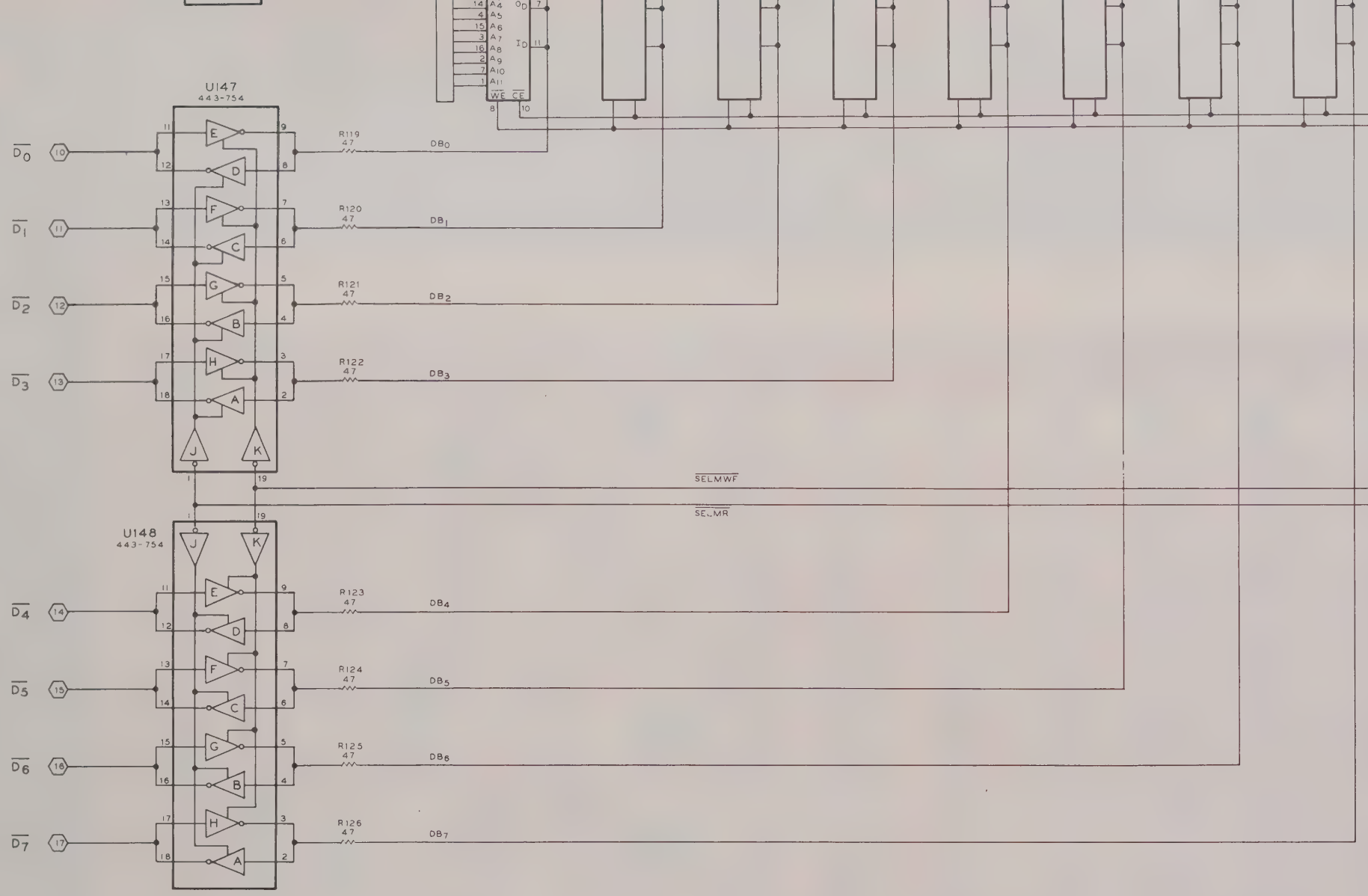
A. Find the circuit component number (R101, C115, etc.) on the X-Ray View.

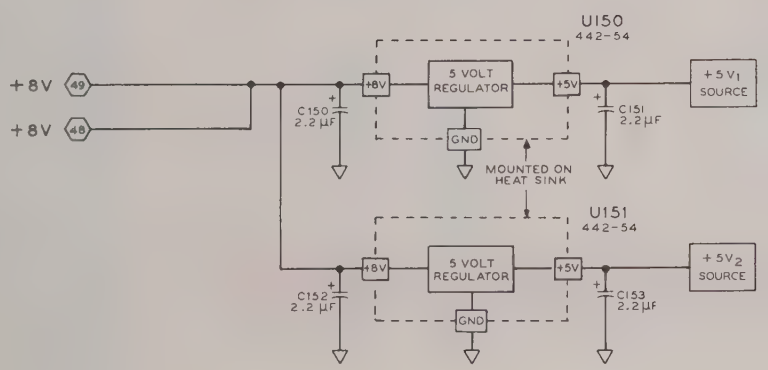
B. Locate this same number in the "Circuit Component Number" column of the "Parts List."

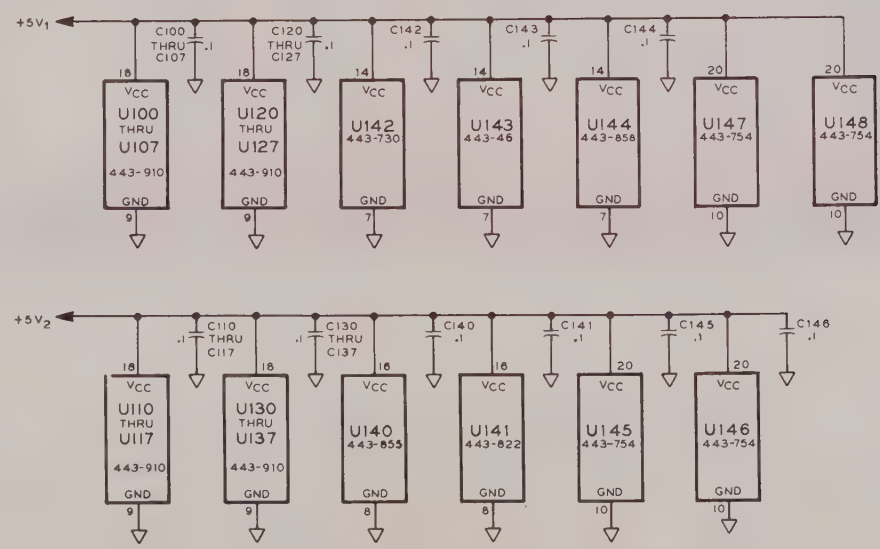
C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION which must be supplied when you order a replacement part.



MEMORY CIRCUIT BOARD
(Shown from component side. Foil on component side is shown in red.)







SCHEMATIC OF THE HEATH WH8-16 16K STATIC MEMORY

NOTES:

1. ALL RESISTORS ARE 1/4-WATT AND HAVE A TOLERANCE OF 5%. VALUES SHOWN ARE IN OHMS.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.
3. SYMBOLS:
   - ▽ CIRCUIT BOARD GROUND.
   - ⬡ SYSTEM BUS (THROUGH CONNECTOR).

Part of 595-2082-03

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MEMR (28) — U144 F (13→12) — $\overline{MEMR}$

$\overline{\emptyset 2}$ (22) — U144 D (9→8) — $\emptyset 2$

MEMW (23) — U144 E (11→10) — $\overline{MEMW}$

$\overline{RESET}$ (29) — U144 A (1→2)

U143 C (8,9→10) — SELMR

U143 B (5,6→4) — SELMW

$\emptyset 2$

U142 443-730: A (D=2, CK=3, R=1, S=4, Q=5, $\overline{Q}$=6 NC); B (D=12, CK=11, R=13, S=10, Q=9, $\overline{Q}$=8 NC)

U144 B (4→3) — $\overline{SELMR}$

R142 2000 → $+5V_1$

$\overline{\emptyset 2}$

$+5V_2$ — R105 2000 — $\overline{BDSEL}$

SW1: 020 (4,7), 040 (3,8), 100 (2,9), 200 (1,10), common (5,6)

R101 2000, R102 2000, R103 2000, R104 2000 → $+5V_2$

U140 443-855: A2 (6) A12S; B2 (2) A13S; C2 (15) A14S; D2 (11) A15S; C1 (7); D1 (12) A15; C1 (14) A14; B (3) A13; A1 (5) A12; Σ_D (10) A15A; Σ_C (13) A14A; Σ_B (1) A13A; Σ_A (4) A12A; A_2 (16) $+5V_2$; C_0 (9) NC; GND (8)

U141 443-822: $\overline{EN}$ (1); B (3) A15A; A (2) A14A; $\overline{EN}$ (15); B (13) A13A; A (14) A12A; GND (8); Y_3 (7) NC; Y_2 (6) NC; Y_1 (5) NC; Y_0 (4); Y_3 (9) $\overline{SELBK\ 3}$; Y_2 (10) $\overline{SELBK\ 2}$; Y_1 (11) $\overline{SELBK\ 1}$; Y_0 (12) $\overline{SELBK\ \emptyset}$

U143 D (13,12→11) — $\overline{MEMSEL}$ (15)

$\overline{A_{15}}$ (45) — U145 H (17→3) — A15

$\overline{A_{14}}$ (44) — U145 G (15→5) — A14

$\overline{A_{13}}$ (43) — U145 F (13→7) — A13

$\overline{A_{12}}$ (42) — U145 E (11→9) — A12

U145 443-754: K (19), J (1), D (8→12), C (6→14), B (4→16), A (2→18)

$\overline{A_{11}}$ (41) — R106 47 — A11

$\overline{A_{10}}$ (40) — R107 47 — A10

$\overline{A_9}$ (39) — R108 47 — A9

$\overline{A_8}$ (38) — R109 47 — A8

$\overline{A_7}$ (37) — U146 H (17→3) — R111 47 — A7

$\overline{A_6}$ (36) — U146 G (15→5) — R112 47 — A6

$\overline{A_5}$ (35) — U146 F (13→7) — R113 47 — A5

$\overline{A_4}$ (34) — U146 E (11→9) — R114 47 — A4

U146 443-754: K (19), J (1), D (8→12), C (6→14), B (4→16), A (2→18)

$\overline{A_3}$ (33) — R115 47 — A_3

$\overline{A_2}$ (32) — R116 47 — A_2

$\overline{A_1}$ (31) — R117 47 — A1

$\overline{A_0}$ (30) — R118 47 — A_0

C148 100PF

R143 270 — U144 C (6→5)

SELMWF

$\overline{SELMR}$

BIT Ø | BIT 1 | BIT 2 | BIT 3 | BIT 4 | BIT 5 | BIT 6 | BIT 7

ADDRESS BUS

U130 443-910: A_0 (12), A1 (6), A2 (13), A3 (5), A4 (14), A5 (4), A6 (15), A7 (3), A8 (16), A9 (2), A10 (17), A11 (1), O_D (7), I_D (11), $\overline{WE}$ (8), $\overline{CE}$ (10)

U131 U132 U133 U134 U135 U136 U137

U120 443-910

U121 U122 U123 U124 U125 U126 U127

U110 443-910

U111 U112 U113 U114 U115 U116 U117

U100 443-910

U101 U102 U103 U104 U105 U106 U107

R128 47 — BANK 3

U143 A (1,2→3) — R135 47

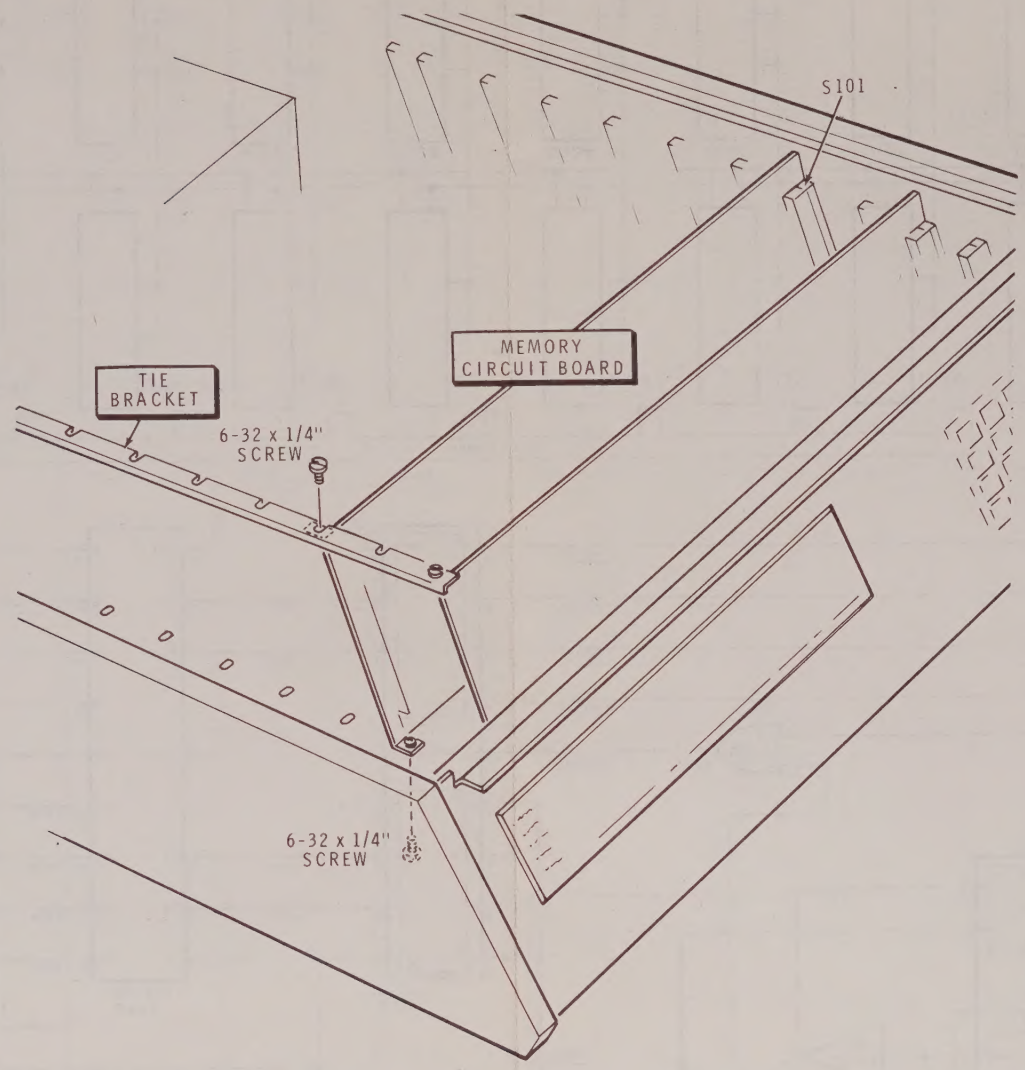
R129 47 — BANK 2

R134 47

R131 47 — BANK 1

R133 47

ILLUSTRATION BOOKLET



PICTORIAL 3

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SERVICE INFORMATION

The following Heath Company services are available if you need them: Replacement Parts, Technical Consultation, and Factory Service. Address all correspondence to:

HEATH COMPANY
Benton Harbor, Michigan 49022

For prompt service, use a separate letter for each department you write to.

Replacement parts and repair service are also available at your nearest Authorized Service Center or Heath Electronic Center. These Centers are listed in your Heath Catalog.

REPLACEMENT PARTS

If a replacement part is needed, please include the following information in your letter:

1. Part number and description.
2. Model Number and Series Number of the equipment.

If your equipment is in the Warranty period, add:

3. Date of purchase.
4. Nature of defect.

Heath Company will fill your order promptly. Please DO NOT RETURN PARTS unless they are requested. Parts that are damaged through carelessness or misuse by the customer will not be replaced without cost.

TECHNICAL CONSULTATION

You can write to our Technical Consultants for help with any Heath equipment, or for answers to any questions about the use of this equipment.

The completeness and accuracy of the advice mailed back to you depends entirely on the information in your letter. Be sure to include:

1. The Model Number and Series Number of the equipment (on blue and white identification label).
2. Date of purchase.
3. An exact description of the difficulty. Include switch positions, connections to other units, operating procedures, voltage reading, and any other information you think might be helpful.
4. List everything you have done in attempting to correct the difficulty.

FACTORY SERVICE

If you do not have qualified repair services at your disposal, you can return your equipment to the Heath Company Service Department to have it repaired for a minimum service fee. (Equipment that has been modified will not be accepted for repair.) Refer to Shipping Instructions for details on how to package and ship the equipment.

To be eligible for replacement parts under the terms of the Warranty, equipment returned for factory service must be accompanied by the invoice or the sales slip, or a copy of either. (If you send the original invoice or sales slip, it will be returned to you.)

SHIPPING INSTRUCTIONS

Check the equipment to see that all parts are in place. Then, wrap the equipment in heavy paper. Place the equipment in a strong carton, and put at least three inches of resilient packing material (shredded paper, excelsior, etc.) on all sides between the equipment and the carton.

Seal the carton with gummed paper tape and tie it with a strong cord. Ship it by prepaid Express or insured Parcel Post to:

HEATH COMPANY
Benton Harbor, Michigan 49022

Attach a letter, containing the following information to the outside of the carton:

1. Your name and return address.
2. Date of purchase.
3. A brief description of the difficulty.
4. Your authorization to ship the repaired unit back to you C.O.D. for the service and shipping charges, plus the cost of parts not covered by the Warranty.

YOUR HEATH DATA SYSTEMS PRODUCT 90 DAY LIMITED WARRANTY

For a period of 90 days after purchase, Heath Company will repair free of charge any product that is defective either in materials or workmanship. We warrant that during the first 90 days after purchase, our products, when used in accordance with our printed instructions, will meet published specifications.

If your Heath factory-assembled product malfunctions or fails to operate at any time during the warranty period, through no fault of yours, we will service it free upon proof of purchase and delivery at your expense to the Heath factory, or any Heathkit Electronic Center, or any of our authorized independent distributor service stations.

Consultation is available on any problem you might encounter in the use of your Heath product. Just drop us a line or give us a call. Sorry, we cannot accept collect calls.

Our warranty does not cover and we are not responsible for damage caused by misuse or fire or unauthorized modifications to or uses of our products for purposes other than advertised. Our warranty does not include reimbursement for customer assembly, disassembly, set-up time, or unauthorized repairs.

This warranty covers only Heath factory assembled products and is not extended to allied equipment or components used in conjunction with these products. **We are not responsible for incidental or consequential damages.** Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

If you are not satisfied with our service - warranty or otherwise, or with our products, write directly to our Director of Customer Services, Heath Company, Benton Harbor, Michigan 49022. He will make certain your problems receive immediate, personal attention.

HEATH COMPANY
Benton Harbor, Michigan 49022

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

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MA24253